EUR 7278 EN

COMMISSION OF THE EUROPEAN COMMUNITIES

Multiannual Programme of the Joint Research Centre 1980 - 1983

1980 Annual Status Report

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Published by the
COMMISSION OF THE EUROPEAN COMMUNITIES
Directorate-General
Scientific and Technical Information
and Information Management
Bâtiment Jean Monnet
LUXEMBOURG

Printed in Italy

ISBN 92-825-2393-4
Catalogue number: CD-NE-81-020-EN-C

SUPER SARA TEST PROGRAMME

1980

Research staff *

Total budget allocated *
for phase I:

Projects:

1. Task Force proceedings and parallel conceptual activity of phase I of the project
2. Design and fabrication activities for the loop and other preparations for phase II of the project

* *Staff and budget allocations are included in Reactor Safety programme, reported under separate cover (i. e. staff: 308; budget: 28.378 KECU)*

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1. HISTORY AND INTRODUCTION

As this status report is the first to be produced since the proposed SUPERSARA test programme (SSTP) was transformed from an Italian into a Community project, it is appropriate first to outline its history and its overall technical objectives.

The SARA loop project was started in 1975 as part of an Italian Government sponsored programme in the ESSOR reactor. It was specified to be a "small cluster" (up to 16 rods, 1.5 m long) programme of research on fuel behaviour for the PWR, BWR and CIRENE reactor types under both normal and accidental conditions, of which the "large break loss-of-coolant accident" (LB-LOCA) was specified to be the major loop design objective. The UKAEA-Harwell was chosen, because of long experience of successful in-pile research, to perform a study of the feasibility of realizing such a loop, and loop design and an estimate of the cost of realization.

In 1976, the Italian Government authorized the initiation of detailed loop design and procurement and the UKAEA-Harwell was chosen as the main contractor. A very important modification to the loop design specifications inserted at this time was the requirement that the loop be made potentially capable of driving "large clusters" (36 rods). This modification resulted from intensive discussions with fuel and safety experts in several countries (including the USNRC) on the role of the SARA project within the world "mosaic" of fuel behaviour research. These discussions revealed an outstanding need for "large cluster" testing aimed at bridging the gap between out-of-pile studies and small cluster in-pile studies on the one hand and the full scale reactor fuel assembly on the other.

In 1978, a further important step was taken: the Italian Government opened discussions with the Commission with a view to transforming the SARA project into a Community programme. Accordingly, a "workshop" was held at Ispra (October 1978), in order to formally review the status of the SARA project with experts nominated by member states, the USNCR and Japan. This resulted in the elimination of the "small cluster" test programme (SARA), and the establishment of the "large cluster" test programme (SUPERSARA) as the principal objective of the loop.

From this background, the programme which emerged as the first SUPERSARA test programme (SSTP) proposal to the Council in 1979 *before* the Three Mile Island accident was to be a study of the behaviour of "large" rod clusters of PWR-type (36 rods, 2 m long) in simulated LB-LOCA conditions. A total of 25 tests was proposed. The main contractor (UKAEA-Harwell) tailored the detailed design of the loop to reach this objective, but the tasks of component procurement initiated in

1976 were considerably slowed down during this period (1978/79) due to uncertainty on the Italian side on the outcome of their proposal to "communitize" the programme (see Fig. 3).

The essential changes to the loop design brought about by the above change of programme were the replacement of a re-entrant by a once-through in-pile section and an increase in the capacity of the loop coolers to reject the "large cluster" power output (~ 2.3 MW). The design studies for these new features, financed by the Commission fund for the study of future JRC programmes and costing 200 kECU, were completed in November 1979 and their fabrication is underway under Italian funding[1].

However, the smooth course of these developments was not allowed to continue. In March 1979, the famous Three Mile Island (TMI) accident took place and necessitated a further review of the SSTP. This review was conducted by internal brainstorming, in consultation with U.S. experts who had been involved in the early diagnosis of the events occurring in the TMI accident. The result of this brainstorming was a new reference programme (August 1979) with diminished emphasis on the LB-LOCA and with a new type of test aimed at an understanding of fuel behaviour in "small and medium break" loss-of-coolant accidents (SMB-LOCA) resembling that at TMI and including wide variations of conditions around the TMI conditions. There were to be 10 LB-LOCA tests and 13 SMB-LOCA tests.

There are very important differences between the thermohydraulic sequences involved in the two types of accident. In the LB-LOCA, the coolant is expelled from the core during a "blowdown" phase of about 30 sec duration, leaving the fuel channels completely voided and subjected to a "heat-up" from the low power decay heat. However, very soon, after about 20 sec, the emergency reflood water starts to rise up the core, gradually quenching the fuel assemblies and completely submerging them after about 200-300 sec. The fuel damage which is expected to occur during this sequence consists of clad ballooning, rupture and slight oxidation, which, while not severe, may potentially degrade the efficiency of the emergency cooling.

In the SMB-LOCA, a very large variation of sequences is possible, but not very great fuel damage occurs unless the coolant in the system becomes so depleted (by gradual leakage) that the water "boils down" to a level significantly below the top of the core, leaving the upper part of the fuel assemblies to suffer an "uncovery transient" during which clad temperatures may rise to the level of "severe fuel damage" (SFD) and enhanced "fission product release" (FPR), depending on the length of fuel uncovered and the manner of re-submergence.

The problem posed in August 1979 by the introduction into the SSTP of tests which simulate the SMB-LOCA was thus that of demanding that the SUPERSARA loop should be made capable of conducting "boil-down", cluster "uncovery transients" in addition to LB-LOCA transients. The brainstorming at Ispra concluded that the loop modifications necessary to conduct boil-down transients would involve rather few new components, for example a "high pressure injection" (HPI) system, a system to obtain small coolant ejection rates and systems of control on the HPI, pressure, cluster temperature and reactor power (see section 2.2.1 for more information).

However, it was only the main contractor (Harwell) who could integrate the new requirement correctly into the loop design. Accordingly, in August 1979, Harwell was presented with this *second* major change in the test programme and asked to study the feasibility of attaining a wide range of cluster uncovery transients by means of minimal changes to the overall loop design. This feasibility study, financed by the Commission fund for the study of future JRC programmes and costing 32 kECU, was completed with positive results in October 1979. Since then the detailed design of the loop modifications, under funding to be attributed to the Italian government[1], has been carried out and completed at the end of 1980.

Pausing briefly in this historical survey, it is important to underline here that the above Harwell feasibility study and design work gives assurance on the performance of boil-down transients only from the viewpoint of *loop thermohydraulics*. There remains a need for *Ispra* to give assurance on the in-pile test-train which must be designed and fabricated to carry out the central objective of the tests: the study of the severe fuel damage (SFD) occurring in a rod cluster during boil-down transients. This severe fuel damage test-train (SFD-TT) must be able to contain the expected high temperature processes without any threat to the once-through in-pile pressure tube.

A very important element entering the SUPERSARA programme in connection with the in-pile test-trains for the boil-down tests (SFD-TTs) is the persistent wish of the USNRC to participate in this area. Data on the behaviour of fuel clusters during boil-down transients has been assigned high priority in the U.S. and the USNRC has made known their interest in supplying SFD-TTs for three such tests in SUPERSARA, plus the pre-analysis and manpower needed to make these tests effective, plus instrumentation for similar test trains built in Europe. Thus the above mentioned problems of test-train feasibility are under intensive study also in the U.S., in particular, at the Battelle Pacific Northwest Laboratory (PNL) which has been nominated the principal contractor of the USNRC for the supply of the SUPERSARA SFD test-trains and general support. It is of great significance that Battelle PNL will also supply SFD-TTs for the boil-down tests planned in the PBF reactor at EG&G-Idaho, starting in 1982.

Returning again to the interrupted historical survey of the project, the initiative was taken by the JRC in August 1979 to update the SSTP by proposing a much broader spectrum of tests to cover not only the LB-LOCA sequence but also a whole range of SMB-LOCA conditions, going as far as severe fuel damage (SFD). This initiative, considered vital to the relevance and validity of the project, was taken while the procedures of obtaining Council approval of the project were already underway. The Council had, therefore, the problem of deciding upon a project which was in a state of flux, so it is not surprising that when Council approval finally came in March 1980, it was made conditional upon the execution of the project in two phases.

In the words of the Council minutes (March 18th, 1980), the Council approved "... the implementation of the SUPERSARA project including ... experiments on loss of coolant through small and medium sized breaks. However, the financial appropriation for the project (43.92 MECU), which is thus approved, comprises one portion to be immediately available viz. 3.31 MECU necessary for the work in 1980" (phase I) "while the remaining portion (40.61 MECU), for the years 1981 to 1983, is frozen" (phase II). "At the end of 1980 ... on the basis of the new information then available, the Council will be required to decide on the continuance of the project and on the release of the remianing portion of the appropriations ...".

The essential tasks of the JRC for the SUPERSARA project during 1980 were therefore twofold:

1. Actuation of an international Task Force with which to:
   a. discuss in depth the test objectives and the relationships between the SSTP and the world mosaic of activities in the field of LWR fuel behaviour;
   b. establish a consensus test matrix;
   c. identify and discuss the major technological problems affecting the feasibility of attaining the consensus test objectives, especially for the boil-down SFD tests.

   A Task Force with these objectives was necessary in order to provide the elements for a Council decision on phase II.
2. Conservation of the rythm of the main contractor (UKAEA-Harwell) and subcontractors for the timely fabrication of loop components and the timely design of those new aspects of the plant necessary for the boil-down SFD tests. This task, maintained by Italian governement funding[1], was necessary to ensure no large slippage in the loop construction schedule, taking the risk, however, that important disharmonies could arise between the loop design and the consensus tets programme if the latter turned out to be greatly different from the one proposed by the JRC in August 1979. (Note: this did not happen.)

2. ACTIVITIES DURING PHASE I

From the above historial background, it will be understood that a presentation of phase I of the project must be formulated under two headings:

- proceedings of the Task Force and parallel conceptual activity at Ispra;
- activities of design and fabrication.

2.1 Task Force[2] and parallel conceptual activity

2.1.1 Results of the Task Force: the consensus test programme

During the period June - October, 1980 the Task Force held four meetings, supported by two specialist "brainstorming" sessions. Within this relatively short time, a consensus was gained on the SSTP and on the technological problems requiring solution before some of the more severe tests can be performed.

The first basic objective of the consensus SSTP is the attainment of data and a deeper generic understanding concerning those aspects of LWR fuel cluster behaviour which can lead to significant *fuel damage, core blockage and coolability problems* as a result of hypothetical accident situations of a low probability where normal safeguard systems are assumed to be partially or wholly in-operative.

In addition to such an understanding of the thermomechanical and thermohydraulics processes governing LWR fuel cluster damage and blockage, a second basic objective is the correlation of the transient *fission product release* (FPR) occurring during accident situations with the type and extent of the fuel damage provoked. In relation to the programme proposal made prior to the Task Force (August 1979) this objective represents a *new* requirement concerning the loop performance.

The consensus SSTP covers fuel cluster behaviour both for the transient conditions of the *"large break" loss-of-coolant accident* (LB-LOCA) and the transient conditions of other accident scenarios which under certain circumstances could lead to periods of partial core uncovery and higher clad temperatures and a potential for *severe fuel damage* (SFD). An important example of such a transient leading to SFD is provided by the Three Mile Island (TMI) accident.

The majority of the Test Force considered from the beginning that more emphasis should be placed on the SFD part of the programme than on the LB-LOCA part. The reason for this is essentially that, while a considerable amount of work has been started or completed for the LB-LOCA, activities in the SFD field are relatively behind and require intensification in order to provide SFD data as quickly as possible.

The LB-LOCA part of the consensus SSTP has been established on the basis that it must be *confirmatory* with respect to the current out-of-pile LB-LOCA fuel behaviour programmes such as REBEKA at the KfK-Karlsruhe (which are able to scope well the governing parameters and require only limited in-pile checks to confirm the typicality of rod-simulator performance) and *complementary* with respect to the current in-pile LB-LOCA programmes such as PBF at EG&G-Idaho and PHEBUS at Cadarache, France (where the data available or expected should be backed up by in-pile tests which give something *new*).

The SUPERSARA loop is being fabricated with the design aim to simulate the entire LB-LOCA scenario, blowdown to reflood, by means of control actions on valves and cluster power. This capability will be exploited in order to meet the basic objectives stated above, which, for the LB-LOCA take on the following particular form:

- Clad deformation characteristics, likely to be dominated by high strain-rate ballooning, influencing the degree of

cluster blockage.
- Interactions caused by deformations which might influence the cluster blockage fraction.
- Rod cluster coolability and thermal response during reflooding.
- Dependence of FPR on the extent of cluster damage.

The Task Force has proposed an LB-LOCA test matrix which fits within the required confirmatory/complementary context by means of the following tests:
- 4 tests with 2 m long PWR (type 17x17) clusters of 32 rods;
- 1 test with a 2 m long BWR-type cluster (probably type 8x8R);
- 2 unspecified tests to cover unforeseen requirements of high priority arising at a later stage.

In contrast to the LB-LOCA part, the SFD part of the consensus SSTP seeks to generate a more comprehensive range of data. There is not currently the wide variety of activity for SFD as for the LB-LOCA field: the only other known comparable SFD programme is that planned for the PBF at EG&G-Idaho, starting in 1982. The PHEBUS programme may also propose SFD tests, in which case these will also have to be considered. For the time being, the SSTP has to ensure a good complementary/confirmatory relationship only with the PBF programme.

Considering the basic objectives stated above and the large array of accident scenarios which may potentially lead to SFD, as occurred in the case of the TMI accident, the SUPERSARA loop has the design aim to simulate the essential common feature of all the SFD scenarios: cluster boil-down and uncovery to provoke relevant transients of clad temperature in combination with relevant transients of system pressure, followed by re-submerge and quenching. The Task Force agreed that this capability be used to address the following particular SFD objectives:

a. Degree of cluster blockage and FPR due to *clad formation* and rupture at low strain-rates possible in "core uncovery" transients, especially considering the effects of clad oxidation on such deformation in the high α- high β range ($\sim$ 1100 - 1650 K).
b. Degree of cluster blockage and FPR resulting from the formation of a *rubble bed* due to the widespread oxidation of the rods (up to $\sim$ 1900 K), with or without prior ballooning and rupture, followed by rod fragmentation either by quenching (re-submergence) or system depressurization.
c. Degree of cluster blockage and FPR resulting from the formation of a Zr/UO_2 liquid solution above $\sim$ 2070 K (rod "candling"), with or without subsequent rubble bed provocation by quenching.

The Task Force proposed an SFD test matrix which fits within the required complementary/confirmatory relation with PBF, attained by means of the following tests:
- 3 tests with objective (a), all with 2 m long PWR* type clusters of 32 rods;
- 4 tests with objective (b), 3 with a 2 m long PWR* type clusters of 32 rods, 1 with a 2 m long BWR⁺ type cluster;
- 5 tests with objective (c), 4 with a 2 m long PWR* type clusters of 32 rods, 1 with a 2 m long BWR⁺ type cluster;
- 2 unspecified tests to permit the inclusion of unforeseen objectives which may later become of high priority.

In connection with tests dedicated to objectives (b) and (c) above, the Task Force recommended that, if possible, the blockages which may be formed during the high temperature and quench phases of the test transient should be characterized by in-pile measurements at low power conducted some time after the completion of the transient. If successful, such measurements would give direct data on "coolability" *before* the damaged configuration is altered by handling operations on the test-trains.

This test requirement is also new with respect to the previous programme proposal and, together with the requirement that the FPR be monitored and sampled, represents a *third* change in the loop operational specifications brought about by the evolution of the test objectives (see history in Section 1). These changed specifications are considered to be tractable as part of the detailed design review currently being conducted by the main contractor to give the loop the desired boil-down, SFD capability.

In conclusion, the consensus SSTP is composed tentatively of an overall number of 21 tests which seem to offer a this moment a reasonable coverage of many of the important accident conditions currently of interest, taking into account the other programmes in the fuel behaviour field.

The Task Force underlined a number of technical problems requiring clarification, but only one, considered central, will be mentioned as an example: protection of the in-pile pressure tube and loop from the high temperature processes of interest. This problem must be solved by the development of a severe fuel damage test-train (SFD-TT) incorporating thermal shielding and fragment catching structures, and a system for de-superheating very hot steam.

On the side of the loop, systems for dealing with the hydrogen produced by the hot Zr/H_2O reaction must be added. These and other similar measures will be undertaken as part of the normal activity for phase II of the project (see Section 2.2).

2.1.2 Conceptual activity at Ispra

Theoretical analysis and scoping calculations were conducted in order to quantify the test parameters, provide a basis for more detailed test specifications and provide vital data for test hardware design and procurement during phase II.

In the area of reactor physics, the test-fuel enrichments necessary to obtain the desired cluster fission power distribution were evaluated. In the area of thermohydraulics the fuel rod temperature history for the LB-LOCA tests was scoped and the loop and reactor conditions necessary to yield the desired histories were investigated. In addition, codes for

* The PWR clusters will all be of 17x17 type geometry
⁺ The BWR clusters will probably be of type 8x8R

the calculation of the boil-down transient for the SFD tests and for the radiative/convective heat transfer in the hot zone of the cluster were developed (not yet to completion). In the area of fuel behaviour (thermomechenical) the FRAP-T class of codes (U.S. in origin but modified at ispra) were used to assess rod ballooning and rupture for the LB-LOCA tests and a contract was established with the University of Stuttgart (FRG) to apply codes developed there (EXMEL, MELSIM) to assess clad melting and re-location in the boil-down SFD tests.

2.2 Activities of design and fabrication

2.2.1 Loop description and procurement status

The SUPERSARA loop is a high-pressure water system capable of testing fuel bundles at various pressures and temperatures. A simplified flow circuit is shown in Fig. 1. As the specification that it should be capable of reproducing the sequence of the LB-LOCA was made right at the start (see history, Section 1), it follows that a large proportion of the components fulfilling this specification have been ordered and are in manufacture. Installation of the plant is programmed to start in the ESSOR reactor in mid-1981 with the first out-of-pile LB-LOCA based commissioning tests planned for mid-1982, to be followed 6 months later by the LB-LOCA in-pile commissioning.

As explained in the history (Section 1), the UKAEA-Harwell has demonstrated the feasibility of modifying the loop to carry out SFD experiments. A general design study is now being completed to examine in detail the implications of these difficult experimental requirements. Specification and procurement of additional loop components will take place in 1981 following the completion of the design study.

The basic loop parameters are:

In-pile test-section power (PW Mode)	2.26 MW (max fissile)
Out-of-pile test-section power (PW Mode)	2.26 MW (max electrical)
Main-loop flow	12 kg/s (maximum)
Design pressure:	
Main circuits	20 MN/m²
In-pile test-section	18 MN/m²
Loop material:	
Main circuit	316L stainless steel
In-pile test-section	Zr-2,5Nb alloy
Main-loop pipework	3 in. nominal bore
Pressure-vessel code:	
Main circuits	ASME III Class 1
Secondary circuit	ASME III Class 3

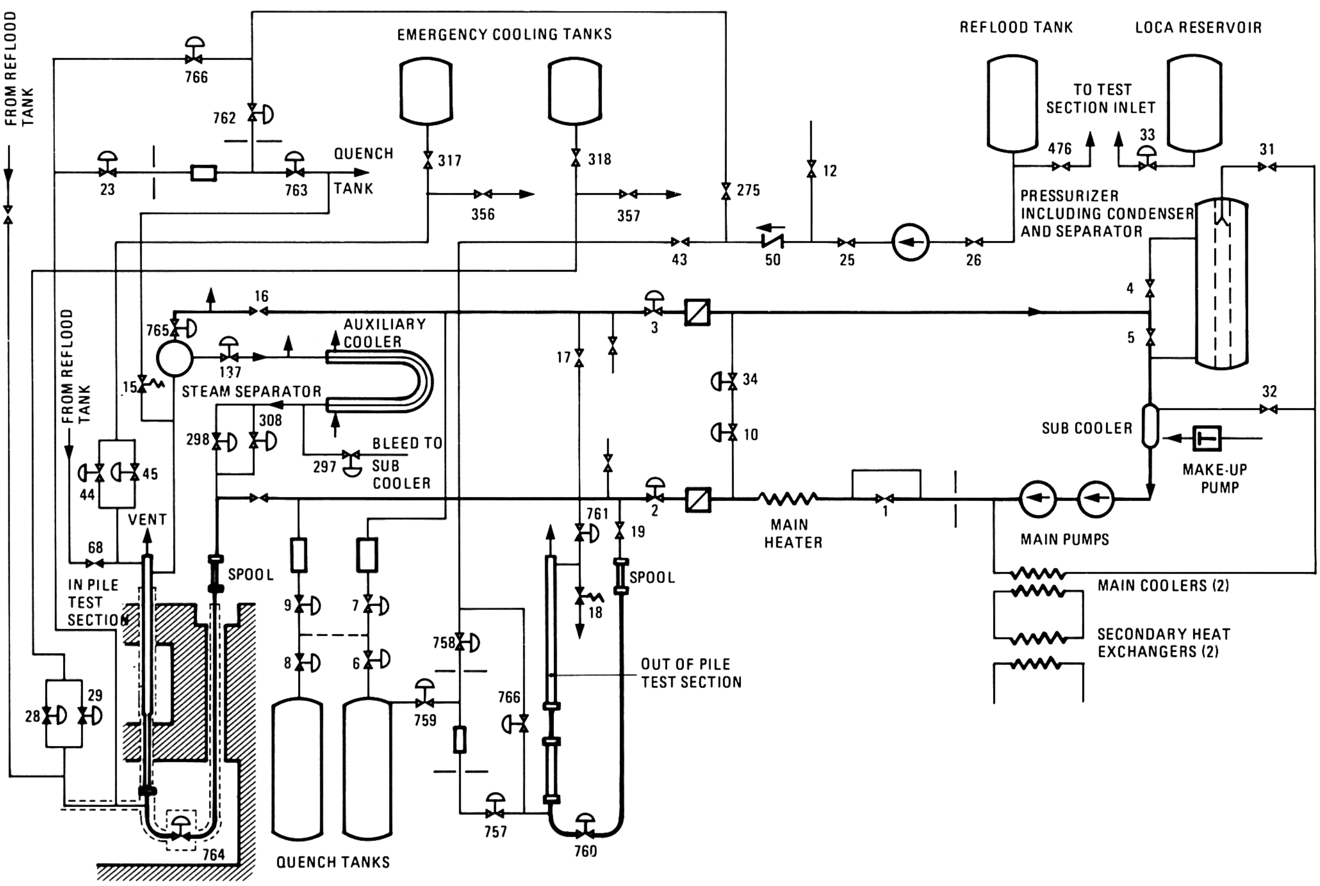

Fig. 1. SARA flow diagram for LOCA tests (simplified)

Figure 1 shows a simplified flow diagram of the loop. The principal loop components are the main circulators, flow meter, main heater, filter, shut-off valve (V2), inlet quality meter, test section, steam separator, outlet-quality meter, shut-off valve (V3), filter, pressurizer, subcooler and, on a bypass line, the main cooler and the purification circuit.

The loop feeds two different test-sections, the in-pile test section, and a parallel twin test section containing an identical, but electrically heated, rod bundle whose purpose is to check the loop thermohydraulic behaviour in advance of the nuclear tests. the arrangement is expected to give vital information for the proving of the in-pile test programme and its subsequent detailed execution and analysis.

Under normal steady operating conditions, water is pumped through the main-loop heater (1 MW capacity) which is used to obtain the desired water temperature or steam quality at the inlet to the test section. Valves V2 and V3 are open and V10 and V34 in the bypass line closed. The water is heated further by the test fuel in the in-pile section before passing to the subcooler when in PWR mode, or the condenser if BWR mode operation is desired. Cold water from the main cooler is mixed with the main loop flow in the subcooler to provide subcooled water at the pump inlet. Pressure in the loop is controlled by a heater in the pressurizer when operating in PWR mode and by the pressurizer spray when operating in the BWR mode.

LB-LOCA test operations

The basic loop circuit has a number of special features to permit LB-LOCA simulation. Before an LB-LOCA test is initiated, the loop is divided into two parts by the closing of valves V2 and V3 and the opening of the bypass line valves V10 and V34. This ensures that if any damage occurs to the test assembly during a LOCA test, all fission products are retained in a relatively small region of the loop and prevented from being swept around the main out-of-pile loop circuits in the bunker.

After isolation of the test section by V2 and V3, V6 and/or V8 are opened to depressurize the test channel into the quench tanks at a rate controlled by V7 and/or V9; in certain experiments V765 may also be used for control. Upon completion of blodown, V764 is closed to isolate the cold leg, and the pipework below the test section is refilled rapidly as the reflood pump injects water from the reflood tank through V766. V766 closes when the water is just below the section, and a pause ensues while the test fuel rod cluster heats up. Although no flow is required, the reflood pump recirculates its putput through the reflood tank to avoid overheating.

Reflood is initiated by opening V23. If 'cyclic reflood' is required then V763 is oscillated open/closed to allow water to be rejected from the test section (which has a blanket pressure of ~ 2 bars, controlled by V7).

Upon completion of reflooding, V766 opens again to allow fast flooding of the upper test section. As water reaches the steam separator, V764 opens again to flood the cold leg and permit long term thermosyphon cooling to begin. When this circuit is full, all reflooding water is cut off by closing V766 and V23.

Boildown SFD: proposed new components

To carry out these tests some modifications to the SARA loop will be necessary. The main features of the modified loop are shown in Fig. 2 and consist of:

a. A high pressure reflood pump and reflood tank make-up pump, which will supply cooling water to the pressurized in-pile test section. This water will be evaporated in the partially uncovered fuel bundle, giving a "boil-down" situation, and then pass to the quench tank.
b. Special instrumentation for the detection of fission products which will include a gamma spectrometer.
c. Spray cooling of the steam as it leaves the fuel to keep the pressure vessel and pipework below their design temperature.
d. A cooling jacket around the blowdown pipe in the quench tank, which will condense the steam as it arrives. Any hydrogen content will be retained.
e. A hydrogen recombination unit, which will deal with the hydrogen accumulating in the quench tanks.
f. A recirculating gas system which will provide external cooling for the pressure vessel and which will reject heat to the reactor D_2O.
g. A control system to regulate fuel cladding peak temperature by controlling the water boil-down level in the fuel bundle.
h. A blowdown control valve, controlled from a pressure sensor, which will regulate system pressure.
i. Another steam pressurizer with a control valve which may be necessary to stabilize system pressure.

The need for a very special test-train to combine with the above modifications and provide adequate containment of the SFD processes has already been explained in Section 2.1.1.

Loop procurement status

The procurement of the loop components has continued on schedule. Fig. 3 shows the rythm of component ordering and an identification of some of the main orders. It is an S-curve typical of such projects except for the evident freeze during the period 1978-79 when the Italian sponsors had serious doubts concerning Community approval of the SUPERSARA project. The components already ordered at the end of the 1977, pressure vessels and main pumps, are being dispatched to Ispra in the period mid-October 1980 - April 1981.

The following subcontracts have been placed in 1980: valves, auxiliary pressure vessels and filters, auxiliary pumps, instruments, electrical components.

The following subcontracts have already been approved and the subcontracts will be placed in october 1980: graylocs, glove box, Zr-Nb material.

The tender action and assessment was completed and the contracts finalized for the following subcontracts: out-of-pile test section heaters, motor alternator sets, installation.

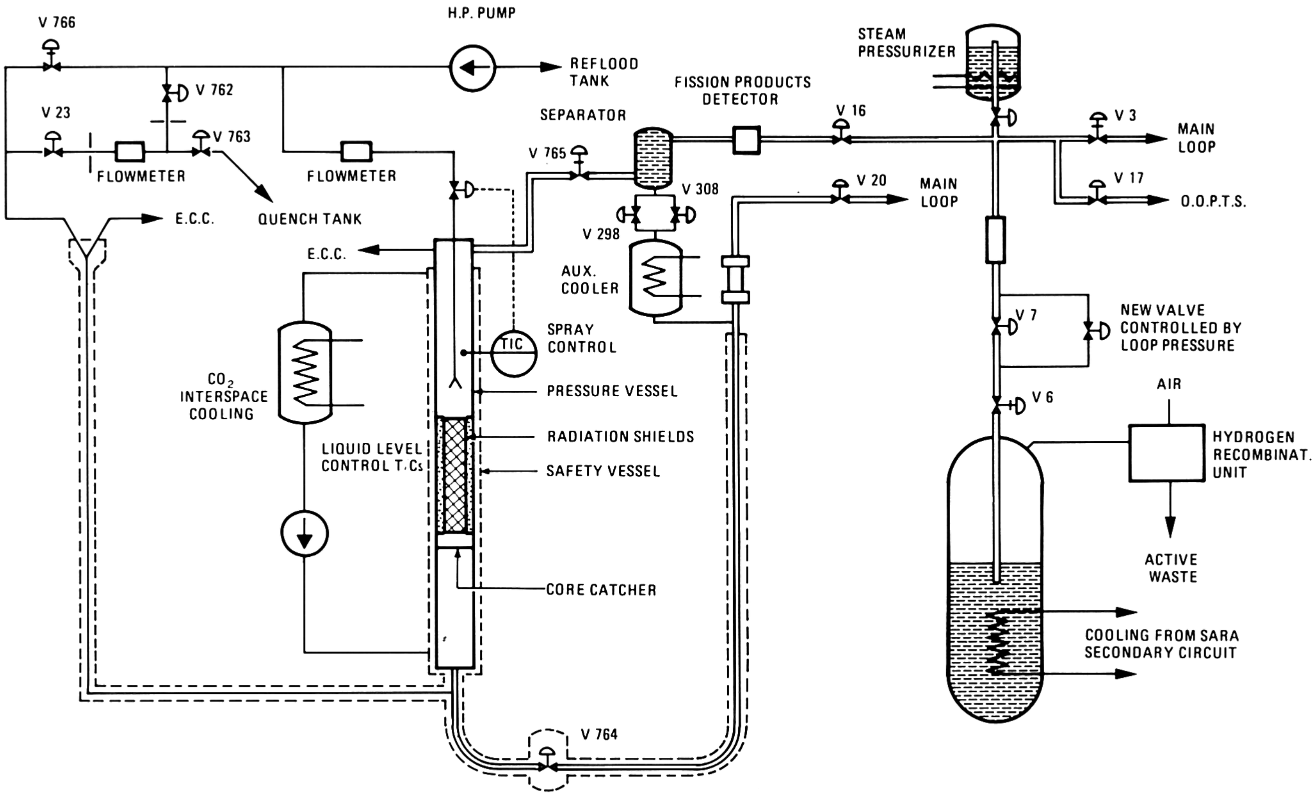

Fig. 2. SARA loop flow diagram for severe fuel damage experiments

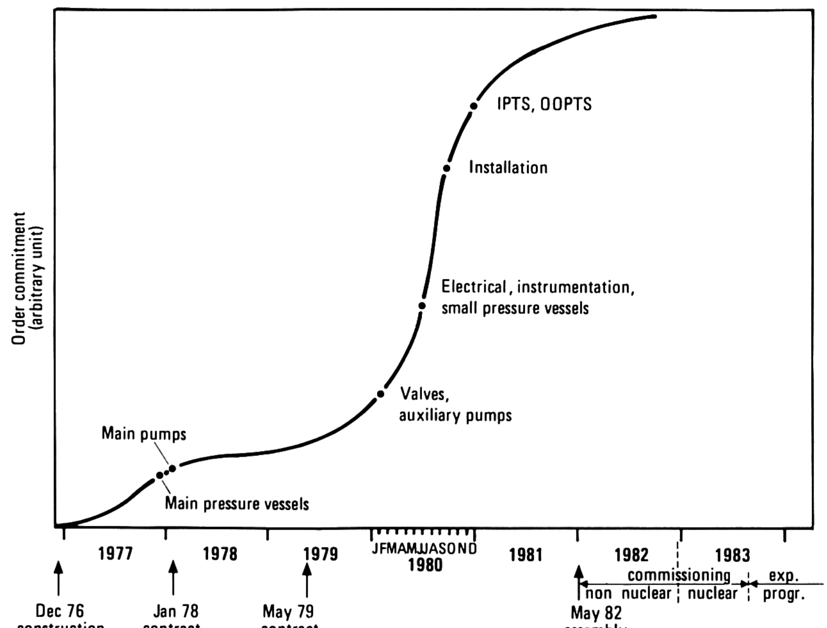

Fig. 3. SARA construction - Accumulated commitment

The remaining contracts, listed below, will be placed during 1981, in agreement with the schedule for the SARA loop shown in Fig.3 : in-pile test section and out-of-pile test section manufacturing contracts, out-of-pile test section power supply.

The procurement status described above refers to the loop design and construction specified to perform the LB-LOCA experiments. The components and systems necessary to carry out the SFD experiments will mostly be specified during 1981 and tender actions will then start.

The Critical Path Network of all activities involved in the loop design and construction should be continuously reassessed with a view to minimize delay due to the additional features already specified and those that could be defined by further design and analysis, above all, in connection with the SFD-TT.

2.2.2 Design activities in preparation for the test programme

The activities described above in Section 2.2.1 concern the preparation of the *loop* and its installation in the ESSOR reactor. The loop and reactor alone are quite insufficient to perform the desired tests: other equipment is necessary. This section summarizes the work done during phase I to prepare this additional equipment.

General design studies for the realization of a working pool for operations on irradiated test-trains and pressure tubes within the reactor containment have continued, taking account of the constantly evolving experimental requirements (e.g. the new FPR objective proposed by the Task Force). Similar studies, necessary to upgrade the active waste disposal systems, have been undertaken.

Preliminary specifications of the instrumentation requirements for the LB-LOCA in-pile and out-of-pile test-trains were completed. Self powered neutron detector development was sponsored under contract with the CEA-Grenoble.

The general design of the instrumented LB-LOCA test-train was completed; detailed design of the out-of-pile test-train is underway at Harwell on the basis of Ispra specifications. Conceptual studies of the SFD test-train are underway in collaboration with Battelle PNL.

Design of a neutronics mock-up to confirm the reactor physics calculations was completed.

As support to fuel rod instrumentation development, five single rod burst tests were conducted in the EOLO-JR helium loop in the ESSOR reactor.

Tentative specification of the loop and reactor operating sequences for both the LB-LOCA and SFD type of test were completed.

A design study of the loop transient thermohydraulics instrumentation systems for the 5 loop spoolpieces was completed under a special contract with Harwell, financed during 1979 by the fund for future JRC programmes and costing 98 kECU.

Contacts were made with the CEA FLASH project in the SILOE reactor and negotiations are underway to establish a study contract for the design of the fission product release (FPR) monitoring system demanded by the new FPR objective.

The general specifications of the data acquisition system (DAS) were established and a start made to establish the general requirements of the test programming and monitoring system (PMS) in collaboration with Harwell.

The general requirements for PIE of the LB-LOCA programme were defined. There was less progress concerning the general requirements for the SFD programme, which are more difficult to establish.

Design studies for an automatized rod metrology system for measuring rod ballooning were completed under contract with CISE-Milano.

Studies for a whole-cluster neutrography ystem were completed, indicating feasibility but high cost.

Negotiations were started to establish a contract with an expert to set up a critical path network plan for the whole project.

2.2.3 Organization at Ispra in preparation for phase II of the project

During phase I, the General Director of the JRC initiated measures to insert the SUPERSARA project into the framework of the existing JRC matrix organization. A programme manager was appointed and assigned a small team of appropriate specialists to coordinate the project after the launching of phase II. During phase I, this team laid the foundation for creating Activity Sheets covering all project activities and took the first steps towards comprehensive project planning and monitoring based on the critical path network (CPN) system.

3. CONCLUSIONS

Taking into consideration the fact that this is the *first* status report written for the SUPERSARA project as a *Community* enterprise, and considering that the project has an important history prior to 1980 as an *Italian* sponsored project, it is felt necessary to formulate the conclusions of the report with a somewhat broader perspective than would otherwise be appropriate.

1. The project has been successfully transformed from an Italian into a Community enterprise. Through the medium of a Task Force, phase I has resulted in a consensus test matrix which forms an adequate basis for the completion of loop construction and detailed planning and execution of the test programme, provided that certain technological problems are solved in the course of the phase II of the project.

2. The consensus test matrix covers the study of fuel rod cluster behaviour over a wide range of accident conditions ranging from the large break loss-of-coolant accident (LB-LOCA) to core boil-down and uncovery transients with a potential for severe fuel damage (SFD). The main technological problems to be solved in phase II concern the high temperature SFD tests.

3. The procurement of the loop components for the LB-LOCA tests was started in 1976 and is scheduled for completion (including commissioning) in mid-1983. The procurement of some of the loop components for the SFD tests started during phase I but other components are still subjected to uncertainty and the effect of the SFD modifications on the overall schedule of loop construction has still to be assessed. The cost of loop construction has been and will be carried by the Italian government.

4. The preparation of other equipment, concepts and analysis necessary for the realization of the consensus programme has gone on in parallel with the activities of the Task Force and the loop procurement activities of the main contractor (UKAEA-Harwell).

5. The ultimate benefits of the SUPERSARA project will be the extension of the data base on fuel behaviour and fission product release necessary for the better assessment of public safety and the specification of plant operator response.

6. Being a large and expensive facility and a major item in the overall JRC research programme, SUPERSARA will be one of the dominant elements in the world-wide mosaic of research which influences the alignment of national programmes in the field of fuel behaviour.

1 By an agreement in May 1980, all funding for SUPERSARA loop design and fabrication work is to be covered by an advance made by the Commission and later to be repaid by the Italian government when phase II of the SSTP is approved by the permanent representatives. The total amount advanced was 5 MECU to cover activities in 1980-81.

2 The Task Force contained delegates from all member states (except Luxemburg) plus active observers nominated by the USNRC. A Japanese observer participated in the first meeting.

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